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**Is Foreign Trade (Im)Perfectly Competitive?:
An Analysis of the German Market for Banana Imports**

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IS FOREIGN TRADE (IM)PERFECTLY COMPETITIVE?: AN ANALYSIS OF THE GERMAN MARKET FOR BANANA IMPORTS.

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Many studies have been carried out that measure welfare effects of the newly adopted common policy on banana imports by the European Community. All these studies assume that foreign trade in bananas is characterized by perfect competition. However, if foreign trade in bananas is imperfectly competitive in structure, then the welfare predictions about the common banana policy may turn out to be incorrect. It is necessary, therefore, to empirically estimate the degree of market imperfection in the banana market. In this paper, we estimate the degree of market imperfection in the German market for banana imports using a structural econometric model. Based on the bootstrap procedure, we reject the hypothesis that this market is perfectly competitive in structure, but cannot reject the hypothesis that firms are engaged in Cournot-Nash behavior.

1. Introduction

In the last decade, there has been renewed interest in conducting empirical analysis in industrial economics, which is now commonly referred to as the "new empirical industrial organization" (NEIO). Compared to the Structure/Conduct/Performance approach of the 1960s and 1970s, which focused on reduced-form, cross-section regression analysis of industries (Schmalensee, 1989), the more recent approach has been characterized by the use of structural

econometric models (Bresnahan and Schmalensee, 1987). The key difference between the two methodologies has been that while the former tended to assume the existence of market power across a sample of industries, the latter has been aimed at directly estimating market power in a specific industry.

To date, there have been in excess of ten applications of the new methodology to specific industries in the food manufacturing and related sectors, including Just and Chern (1980), tomato harvesting; Lopez (1984), Canadian food processing; Schroeter (1988), beef packing; and Azzam and Pagoulatos (1990), meat packing/live animals. However, very few studies have used this type of analysis with respect to export markets, the exceptions being Buschena and Perloff (1991), coconut oil export market; Karp and Perloff (1989, 1993), rice and coffee export markets; and Lopez and You (1993), Haitian coffee exporting.

Estimating the degree of imperfect competition in international markets is not just useful in and of itself, but is also important in the context of developments over the past fifteen years in international trade theory (Helpman and Krugman, 1985, 1989). The key characteristic of the so-called "new trade theories" (NTTs) is the explicit assumption of imperfectly competitive markets. In models explaining the structure of trade, it is commonly assumed that scale economies can lead to specialization and export in monopolistically competitive markets, e.g. Krugman (1979). More controversially, it has been shown theoretically that the existence of oligopolistic markets may provide a rationale for activist trade policies such as export subsidies, e.g. Brander and Spencer (1985). Although such "rent-shifting" arguments have been shown to be a rather special case (Dixit, 1987), the NTTs have made a significant contribution to understanding how imperfect competition can affect the gains from trade liberalization, e.g.

Smith and Venables (1988), and, also, how different trade instruments can have differential welfare effects when markets are oligopolistic, e.g. Krishna (1989). These developments suggest there is a premium on verifying empirically whether an international market(s) is(are) imperfectly competitive.

The objective of this paper is to estimate the degree of non-competitiveness in the German market for banana imports, a market that has recently been affected by the introduction of import quotas. Given this objective, the rest of the paper is organized as follows: Section 2 gives some institutional background to the German banana import market, while Section 3 describes the methodology followed in the paper. Essentially, the degree of market imperfection in an international market is calculated by estimating a demand function, and the industry first-order profit-maximization condition, from which an estimate of the degree of imperfect competition can be retrieved. Section 4 describes the data used and reports the results of the econometric analysis. In particular, having estimated the demand function, and the first-order condition, the model is then bootstrapped in order to calculate a standard error for the estimated parameter reflecting the degree of imperfect competition. Section 5 summarizes and suggests a future direction to this type of study.

2. Institutional Background

The German market for bananas was selected for analysis for two interrelated reasons. First, until the end of 1992, while Germany operated a regime of free trade in bananas, countries such as France, Spain and the United Kingdom had maintained restrictions on imports from so-called "Dollar" countries (e.g. Columbia and Ecuador) in order to ensure high prices

for preferential suppliers of bananas from the African, Caribbean and Pacific states (ACP). As a result, there was wide variation in retail banana prices across the European Community (EC), which would have been unsustainable under the EC's 1992 Single Market process. However, at the start of 1993, in order to promote the harmonization of internal EC banana prices, Germany has had to implement a common policy of an import quota-cum-tariff. The overall EC policy is one where, for the first 2 million tonnes, bananas will enter the EC at a reduced duty, thereafter, the tariff rises to a prohibitive 177 percent (see Read, 1994).

Many studies, most notably Borrell and Yang (1990, 1992), and Borrell and Cuthbertson (1991), have undertaken economic analysis of this policy reform. These papers have used non-spatial models of the EC banana market to derive expected welfare changes given various EC import policy scenarios. In particular, the focus in these studies has been on banana exporting countries rather than production in a vertically-related distribution and retailing system involving private firms. In addition, these studies have assumed that the EC banana market is perfectly competitive, which, given the NTTs, may bias any estimates of the effects of trade policy reform.

However, the assumption of perfect competition does not fit the stylized facts. The sale of bananas is conducted through a complex, international, vertical marketing system, consisting of: plantation production; the wrapping and boxing of hands of green bananas; transportation via high-speed refrigerator vessels; large-scale ripening in the importing country; wholesale distribution and sale to final consumers through supermarket outlets. In addition, various stages of this marketing system can be characterized as imperfectly competitive. The key feature of the world banana export industry is the dominance of three multinational firms, United Brands

(Chiquita), Standard Fruit (Dole), and Del Monte (Read, 1983). Between them, these three firms account for 70 percent of the world market and 66 percent of the European market, United Brands alone accounting for 43 percent (Hallam and McCorriston, 1992). With respect to Germany, three firms (United Brands, Standard Fruit and Noboa) account for 72 percent of the market. This market structure derives largely from the existence of economies of scale in refrigerated shipping and distribution (Read, 1994).

In addition, product differentiation through branding is a key feature of the retailing of bananas. For example, United Brands are reported to be able to sell their Chiquita brand at a price on average between 30 to 40 percent higher than its unbranded bananas (European Commission, 1976). Further evidence of market power in the EC is given by the European Commission's 1976 ruling against United Brands that it abused its dominant market position, and the commencement of a second inquiry into the firm's activities in 1990.

Second, because an effective import quota has been implemented in the German banana market, it becomes crucial to estimate how noncompetitive the market was under free trade. This follows from theoretical arguments in the NTTs that import quotas can affect the strategic behavior of firms. For example, Hwang and Mai (1988) have shown that in a general conjectural variations model, quantitative restraints can generate either pro- or anti-competitive effects, or neither, depending on the initial values of the firms' conjectures, i.e. how (un)competitive the market was prior to the imposition of the quota. In their duopoly model, a quota effectively imposes Cournot behavior on the home firm, i.e. the home firm now knows that if it changes its output, the foreign firm's output cannot change, presuming the quota is binding, which is effectively identical to what is assumed under Cournot behavior. Hence, if

the firm was initially playing more (less) competitively than Cournot, then a quota will make the market less (more) competitive. In this context, the quota can have either pro- or anti-competitive effects. In the case where firms initially play Cournot, the quota has no effect on firms' behavior. McCorriston, Sheldon and Hirschberg (1993) have applied this argument to the changes in the EC's banana import regime. However, a weakness of their analysis, is that their estimate of the degree of noncompetitiveness in the German banana market is based on a simple calibration procedure, to which no statistical significance can be attached. Hence, the value of estimating econometrically the degree of market power.

2. Methodology for Estimating Market Power

Most industrial organization economists agree that the appropriate measure of the degree of market power is the gap between price (P) and marginal cost (MC), i.e., the ability of a firm/industry to raise price above marginal cost. A unitless measure of this is the familiar Lerner index:

$$(1) \quad L = \left[\frac{P - MC}{P} \right]$$

This can be measured directly if adequate data are available. Unfortunately, such detailed information about marginal cost is rarely available. Most of the research in the SCP tradition adopted a proxy for the Lerner index originally introduced by Collins and Preston (1969) which is based on using average variable cost rather than marginal cost. However, except for competitive firms in long-run equilibrium, average (variable) cost is not a good approximation to marginal cost. An alternative index, Tobin's q, which is defined as the ratio of the market value of a firm to the replacement cost of its tangible assets, should, on average, equal one

under competitive conditions. But if intangible assets are large and are ignored in the valuation of the firm, then Tobin's q could exceed one even in the absence of market power. Measures of profits and rates of return are not good substitutes either for the price-cost margin. They use accounting as opposed to economic definitions of cost, employ arbitrary depreciation rules, and do not treat the cost of advertising and research and development reasonably. Fisher and McGowan (1983) indicate that the time profile of the benefits derived from investments, depreciation methods used, and the growth rates of the firms differ among firms, hence, the comparison of accounting rates of return is misleading.

The emergence of the NEIO was to some extent motivated by dissatisfaction over these issues. Survey articles by Bresnahan (1989) and Perloff (1992) show that in the last decade, relatively complete structural econometric models based on formal profit-maximizing theories have been used to estimate the degree of market power in specific industries. This literature has grown in several different directions, the variety reflecting the differences in the availability of data and the institutional details of the industries. The approach followed in this paper is a special case of the model suggested by Bresnahan (1982). The aim is to estimate an industry-wide, average parameter of market power, using a standard structural econometric method.

Suppose market demand in a given industry is given by the implicit function:

$$(2) \quad Q_t = Q(P_t, Z_t)$$

where Q_t is the total quantity demanded, P_t is market price, Z_t is a vector of exogenous variables, and t is a time subscript. Since Q_t and P_t are simultaneously determined, the demand function can equally well be written in inverse form, $P_t = P(Q_t, Z_t)$. Industry revenue is defined as, $R_t = P_t Q_t$, and, therefore, perceived marginal revenue $\{MR_t(\lambda)\}$ is given by the expression:

$$(3) \quad MR_t(\lambda) \equiv P_t + \lambda Q_t[dP_t/dQ_t]$$

where λ is the market power parameter reflecting the wedge, in equilibrium, between price and marginal cost. As will be shown subsequently, nested in λ will be an index of the beliefs that firms have about other firms' reactions to their output choices, i.e. a conjectural variations parameter. In equilibrium, MR_t will equal marginal cost MC_t , which can be written as:

$$(4) \quad P_t + \lambda Q_t[dP_t/dQ_t] = MC_t$$

If firms demonstrate either Bertrand-Nash or competitive behavior, the parameter λ will turn out to be 0, and (4) becomes the usual profit maximizing condition that price must equal marginal cost. If firms demonstrate perfectly collusive behavior, then the value of λ will be 1 so that it reflects the profit maximizing behavior of a monopolist. λ will take the value $1/n$ if the n firms in the market behave in Cournot-Nash fashion. The reason for the Cournot-Nash value of $\lambda = 1/n$ becomes apparent once a connection is made between the market power parameter λ and the concept of conjectural variations.

This connection is illustrated briefly here using a simple duopoly model. Let firm 1 expect firm 2 to produce q_2^e units of output. If firm 1 produces q_1 units of output, the total output it expects to be sold in the market is $Q = q_1 + q_2^e$. The profit maximizing problem for firm 1 is then:

$$(5) \quad \arg \max_{q_1} \{P(Q)q_1 - c_1(q_1)\}$$

where $P(Q)$ is the inverse demand function, and $c_1(q_1)$ is firm 1's total cost function. The first-order condition for this problem is:

$$(6) \quad P(Q) + \left[\frac{dP}{dQ} \frac{dQ}{dq_1} \right] q_1 = MC_1(q_1)$$

where $MC_1(\cdot)$ is firm 1's marginal cost. If the derivatives are treated as discrete changes, then the change in Q can be expressed as: $Dq = dq_1 + dq_2^e$, and, hence:

$$\frac{dQ}{dq_1} = \left[1 + \frac{dq_2^e}{dq_1} \right]$$

In equilibrium, $q_2^e = q_2$, therefore, the equilibrium expression (6) can be re-written as:

$$(7) \quad P(Q) + \frac{dP}{dQ} \left[1 + \frac{dq_2}{dq_1} \right] q_1 = MC_1(q_1)$$

The term dq_2/dq_1 in the above equation is the conjectural variations term. It summarizes how firm 1 conjectures firm 2 will vary its output when firm 1 makes a small change in output. Denote this term as V . If the firms are assumed to be symmetric, i.e. they have identical costs, and, therefore, produce the same level of output, then equation (7) can be generalized to n firms as:

$$(8) \quad P(Q) + \frac{dP}{dQ} \left[\frac{1 + (n-1)V}{n} \right] Q = MC$$

Recall equation (4), and compare it to the equation (8) above. These two are identical equations, where:

$$(9) \quad \lambda = \left[\frac{1 + (n-1)V}{n} \right]$$

From equation (9), it is obvious that if firms behave in Cournot-Nash fashion, i.e. $V = 0$, then the corresponding value of λ is $1/n$.

Given the above theoretical background, the following empirical procedure can be adopted to estimate the degree of imperfect competition in the German banana import market.

Suppose the demand function in (2) is specified in linear form:

$$(10) \quad Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 Z_t + \epsilon_1$$

where Q_t are quantities of bananas sold at retail, P_t are retail prices, Z_t is a vector of exogenous variables (defined explicitly in Section 4), and ϵ_1 is the error term, where ϵ_1 is $N(\mu, \sigma^2)$. In addition, suppose that marginal cost takes the following functional form:

$$(11) \quad MC_t = \gamma_0 + \gamma_1 W_t + \gamma_2 T$$

W_t is the import price of bananas, which is assumed to be a proxy for the cost of bananas to retailers, and reductions in marginal cost due to technological advances in shipping, storage etc. are captured in the trend variable T . Overall, marginal costs are assumed to be constant with respect to output. Given that the banana industry is characterized by high fixed costs in terms of plantation, production and transport costs, a total cost function comprised of fixed costs plus linear variable costs would imply decreasing average total cost and constant marginal cost, a technology commonly assumed in the NTTs (e.g. Krugman, 1979).

Equation (11) can now be substituted into the profit-maximizing condition (4). Rearranging terms, the following linear equation is derived:

$$(12) \quad P_t = \gamma_0 + \gamma_1 W_t + \gamma_2 T + \gamma_3 Q_t + \epsilon_2$$

where the variables are defined as above, $\gamma_3 = -\lambda[dP_t/dQ_t]$, and ϵ_2 is $N(\mu, \sigma^2)$. By differentiating equation (10) with respect to Q_t , it can be seen that $[dP_t/dQ_t] = 1/\alpha_1$. Therefore, the market power parameter is nothing more than the product of two regression coefficients with a negative sign, $\lambda = -\alpha_1 \gamma_3$.

It should be noted at this point that Bresnahan (1982) presented a generalized form of this approach where marginal costs are assumed variable. Let equation (11) have an additional term $\gamma_4 Q_t$ on the right hand side so that MC_t varies with respect to output. Now, the coefficient of Q_t in equation (12) will be $(\gamma_3 + \gamma_4)$. Since marginal cost is not known, the value of γ_4 in equation (11) is not known, and, therefore, the individual value of γ_3 cannot be found, even though the estimated value of $(\gamma_3 + \gamma_4)$ in equation (12) is known. Consequently, λ cannot be identified. Bresnahan showed that this problem can be resolved by adding one more variable in the demand equation, namely $P_t Z_t$. Buschena and Perloff (1991) used this approach to estimate market power in the coconut oil export market. The approach adopted in this paper is a special case of the Bresnahan methodology. Essentially, because marginal costs are assumed to be constant, the identification problem does not arise in the first place.

4. Data and Regression Analysis

In order to evaluate the degree of market power, equations (10) and (12) are estimated. In its complete form, (10) is specified as:

$$(10') \quad Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 Z_t + \alpha_3 T + \alpha_4 TT + \epsilon_t$$

Q_t and P_t are as already defined; Z_t is the German population aged 65-and-above, and T and TT are the trend variables. Conspicuously absent explanatory variables in (10') are the prices of substitute fruits, income and the total population of Germany. As noted by the World Bank (1985), the cross-price elasticity of bananas with other fruits is very low. It is reported as 0 in Germany, which is similar to estimates for other developed countries, e.g. Huang (1993) reports a value of -0.08 for the cross price elasticity between bananas and oranges in the US. Thus, the

choice of bananas in consumption is a matter of customer preference, and other fruits are not accepted as ready substitutes.

The World Bank (1985) also reports that banana consumption is only responsive to income in countries where per capita GNP is less than \$1500. In countries like Germany, with a very high per capita income, banana consumption has reached saturation level with respect to income variations. In addition, the population of Germany has been constant over the time period under consideration. However, the German population is ageing over time, and, therefore, population in the age cohort 65-and-above is growing. Interestingly, a report by the European Commission (1976) states that bananas are regarded as a health food, and they are an important part of the diet of the sick and very old. This justifies the inclusion of the variable Z_t in the demand equation.

Table 1 summarizes and describes the variables used in the estimation procedure. Annual data on aggregate quantities of bananas imported into Germany (Q_t), retail prices (P_t), and import prices (W_t)¹ were collected for the period 1970-1992 from the Food and Agriculture Organization (FAO) publications: *World Banana Economy* (1983) and *Banana Statistics* (1992). Exogenous demographic variables (Z_t) were collected from Warnes (1993), and the International Labour Office (ILO) publication: *From Pyramid to Pillar* (1989)². Other exogenous variables used are a time trend (T) and squared time trend (TT). A consumer price index, used for deflating the nominal variables was collected from the International Monetary Fund (IMF) publication: *International Financial Statistics* (1992, 1994).

¹ Import price refers to f.o.r. price charged by importers to wholesalers at the port of Hamburg.

² Total population figures were available for every year; however, population for age 65-and-above, was reported as a percentage of total population every five years. Other values were interpolated.

Table 1: Description of Variables.

Variable	Description
P_t	Real retail price of bananas in German market: DM/tonne
Q_t	Total quantity of bananas imported into Germany: Thousand tonne/year
T	Time trend = 1, 2,
TT	Squared time trend = 1, 4,
W_t	Real import price of bananas in German market: DM/tonne
Z_t	German population: Age 65-and-above
t	1970-1992

Since equations (10') and (12) represent a simultaneous equations system with P_t and Q_t being determined simultaneously, a two-stage least squares (TSLS) estimation procedure was used to estimate the system, where the instruments used were import price, population aged 65-and-above, time and time squared. The demand equation (10') is exactly identified, and the first-order condition (12) is over-identified. A three-stage least squares procedure was also employed; however, no improvement over the two-stage least squares method was observed. The results of estimating these equations are shown in Table 2.

In the case of the demand equation, the R-square between observed and predicted is 0.95, while that for the first-order condition is 0.46. Although the Durbin-Watson ratios lie in the inconclusive range for rejecting the hypothesis of the existence of autocorrelation, it is also clear that they are very close to the upper bound where the hypothesis of the existence of autocorrelation can be rejected. In the above regressions, the relevant parameters for calculating market power are $\alpha_1 = -0.32$ and $\gamma_3 = 0.91$, both being statistically significant at the 1 percent

level. Therefore, the market power parameter for this industry is $\lambda = -(-0.32)(0.91) = 0.29$. As noted earlier, the German market for bananas is dominated by three firms that account for a market share of about 72 percent. If the rest of the firms are treated as fringe suppliers, then this market can be described as an effective triopoly. In that case, the Cournot-Nash market power parameter for symmetric-sized firms ($\lambda=1/n$) turns out to be $1/3$. The estimated value for λ is much closer to this number than to 0, the value of λ that describes competitive behavior. Hence it would appear that the German banana import market is less than competitive.

Table 2: TSLS Estimation of the Model*.

$$Q_t = 684 - 0.32P_t + 106Z_t - 80T + 4.2TT \quad (10')$$

(1.11) (-3.6) (1.79) (-11.4) (13.0)

R-square between observed and predicted = 0.95
 $D_L=0.77 < DW=1.48 < D_U=1.53$ at 1% significance.

$$P_t = 502 + 1.38W_t - 21.2T + 0.91Q_t \quad (12)$$

(1.34) (4.82) (-2.28) (3.4)

R-square between observed and predicted = 0.46
 $D_L=0.86 < DW=1.35 < D_U=1.4$ at 1% significance.

* Figures in parenthesis refer to t ratios.

As it was not possible to generate an inter-equation variance/covariance matrix for the coefficients in the two equations, which would be necessary for calculating a standard error for λ , for the purposes of hypothesis testing, a bootstrap procedure (Efron, 1979) was conducted in order to estimate an empirical standard error for the market power parameter λ . This procedure enables one to generate a distribution for the parameter in question, and, hence,

permits a test of its robustness. The test can also show the probability of that parameter lying outside the theoretical range.

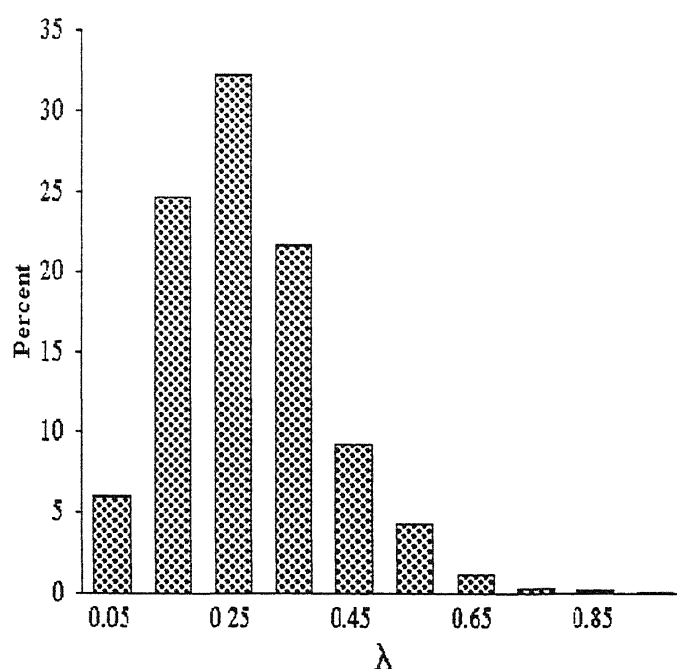
The bootstrap procedure is a computer-intensive, nonparametric approach to statistical inference based on data resampling. It involves saving the regression errors for each observation; randomly sampling the normalized errors with replacement; generating a new dependent variable by using the normalized, resampled errors, and finally, regressing the newly created dependent variable on the explanatory variables. Judge *et al.* (1988) give a good explanation of this procedure. For the present model, this procedure was performed 1000 times on both equations (10') and (12), and λ was then calculated each time. Using these 1000 values of λ , its mean and standard error can easily be calculated, which helps in the conduct of hypothesis testing. On the basis of this procedure, the hypothesis of perfect competition and collusive behavior could be rejected, but the hypothesis of Cournot-Nash behavior could not be rejected.

Table 3: Bootstrapping of the Model*

% of ($\lambda < 0$ or $\lambda > 1$) 0.003 %	Mean value of λ 0.27248	Standard Error 0.13
Hypothesis	Test Statistic	Remark
$H_0: \lambda = 0, H_1: \lambda > 0$	2.1	Reject H_0 at 5% & 2.5%.
$H_0: \lambda = 1, H_1: \lambda < 1$	-5.6	Reject H_0 at all levels.
$H_0: \lambda = .33, H_1: \lambda \neq .33$	-0.7	Cannot reject H_0 at any level.

*1000 iterations performed.

The results of the bootstrap procedure are summarized in Table 3. Figure 1 also gives an idea of the distribution of λ , indicating that the values of λ are concentrated around its mean value.

Figure 1: Distribution of λ 

5. Summary and Conclusions

The aim of this paper has been to generate an estimate of the degree of market imperfection in the German market for banana imports. The rationale for doing this has been that most of the economic studies of the recent implementation of a common EC banana import regime have assumed that the market is perfectly competitive, which is in contrast to the stylized facts concerning the market for banana exports. In addition, results from the new trade theories suggest that the effects of trade reform can be quite different when markets are imperfectly competitive. Therefore, it is important to derive estimates of the degree of imperfect competition in markets affected by trade policy reforms.

Using a structural econometric model, based on a method originally proposed by Bresnahan (1982), the results show that the German banana import market is not perfectly competitive. In fact, firms demonstrate Cournot-Nash behavior. Employing the bootstrap procedure enabled us to judge the robustness of the market power parameter, and conduct hypothesis testing. Even though the bootstrap mean value of λ is a little lower than the classical estimate, the hypothesis of perfect competition, based on the mean bootstrap value, was rejected. In terms of the Hwang and Mai (1988) hypothesis, this result suggests that the implementation of an import quota will not alter the strategic behavior of firms by very much, if at all.

The paper does, nonetheless, leave one aspect ignored. The analysis conducted, is static in nature, however, the literature on repeated games suggests that firms might behave collusively due to the intertemporal strategic interaction among themselves. Therefore, a more accurate formulation of the problem might be achieved by using a dynamic model.

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